Bioinformatics Syllabus

Department of Biochemistry and Molecular Biology

BIOC4010/5010 Winter 2024

Collaborative Health Education Building (CHEB) Rm 140

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Dr. Andrew Roger	andrew.roger@dal.ca	Sir Charles Tupper Med. Building, Rm. 4L05 Office hours: Tues-Thurs 1:35-2:35pm
Kelsey Williamson (teaching assistant)	k.williamson@dal.ca	Sir Charles Tupper Med. Building, Rm. 4L05 Office hours: Tues: 10am-11am, Thurs: 2:30pm-3:30pm
Dr. Daniel Gaston	daniel.gaston@dal.ca	Rm. 511, Mackenzie Building Office hours: TBA
Dr. Morgan Langille	morgan.langille@dal.ca	Sir Charles Tupper Med. Building, Rm. 5D Office hours: TBA

Course Description

This course presents the theory and practice of bioinformatics. This course presents the theory and practice of bioinformatics. Topics include: rate of mutation, sequence alignment, database searching, phylogenetic analysis, bioinformatic tools for analyzing genes, genomes and proteins.

Course Prerequisites

BIOC3400

Student Resources

Office hours for Dr. Andrew Roger and Kelsey Williamson are listed above.

Course Structure

Course Delivery

The course will be delivered in-person and will include a mixture of lectures and computer labs during class time. Lectures will **not** be recorded. Lecture slides will be uploaded to Brightspace immediately prior to the lecture and available for students to download. Note that the uploaded slides do not contain all lecture content. Students should attend lectures to take notes and ask questions to get the most out of this course. Students are also responsible for assigned readings and assigned videos on Brightspace. Note that some readings/videos will be provided for interest (i.e. optional) and will not be required. Readings/videos which are essential versus optional will be clearly denoted as such in the lectures and on the Brightspace page.

Lectures and laboratories

Tuesday and Thursday, 11:35pm-12:55pm in the Collaborative Health and Education Building (CHEB) Rm 140 (see attached tentative schedule that outlines both lecture and lab schedule)

Course Materials

The labs require a laptop computer. Students must bring a laptop to the computer lab sessions.

There is no required textbook for this course. Required weekly course readings and/or video content will be assigned in lectures and posted for download/ viewing on Brightspace.

However, the following books provide good all-round introduction to bioinformatics and is recommended for those with interests in using bioinformatics in their future work:

- ***Bioinformatics 4th edition,* by A.D. Baxevanis, G. Bader and D. S. Wishart (2020) John Wiley and Sons Inc.**
- ***Understanding Bioinformatics* by M. Zvelebil and J. O. Baum, (2008) Garland Science (Taylor and Francis Group) ISBN 0-8153-4024-9**

Brightspace page: https://dal.brightspace.com/d2l/home/309254

Students registered in the class will be able to access all course materials via Brightspace at https://dal.brightspace.com. You can access this site using your Dal NetID and Password. If you need assistance using Brightspace, please contact the Help Desk at 902-494-2376 or helpdesk@dal.ca

A tentative lecture schedule with titles is attached and will also be posted on the Brightspace Course Schedule. **Any announcements or other important information will be posted on the course Brightspace page. *Students are responsible for reading all announcements on the Brightspace page*.**

Assessment

Course Assessment

	BIOC4010	BIOC5010*
Examination #1 (midterm: 1hr, 20mins) (held in class)	32%	27%
Problem sets	10%	10%
Lab assignments	15%	15%
BIOC5010 student presentation*	--	15%
Examination #2 (final: 2 hours) (held during exam period)	43%	33%

*Note: Graduate students will give a 12-minute presentation on a bioinformatics topic to the class. More information on the possible topics will be given during the course.

Assignments : Short problem sets (see schedule for dates) are given over the term that are due **one week after being assigned in class (by 5pm on the day they are due)** and should be uploaded to Brightspace. Lab assignments (see schedule for dates) are due **one week after the scheduled computer lab (by 5pm on the day they are due)** and should be uploaded to Brightspace. **Students may collaborate/work in groups on the activities/tasks in the computer labs but each student must write the answers to the lab questions in their own words (do not submit joint answers)**

Tests/quizzes: A midterm is scheduled for **February 29th.** Note that this is subject to change because of unexpected closures of the university because of weather events (or other causes).

Final exam: 2-hour final exam will be held during exam period (covers entire course)

Conversion of numerical grades to final letter grades follows the Dalhousie Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

For BIOC 5010, grades will be converted to Final Letter Grades as above **except that any grade below 70 (B-) will be converted to an F as per FGS regulations**

Course Policies on Missed or Late Academic Requirements

- Late assignments will lose 10% of their total mark value every 24 hours after the due date. If a student has a medical reason for a late assignment (lab or problem set), **they must provide a Student Declaration of Absence form through the course Brightspace page within three (3) calendar days of the due date, otherwise the late penalties above will be applied**. The onus is then on that student to gain permission for the course coordinator and TA for a new due date for the assignment **otherwise they will receive a mark of zero for the assignment**.

- A student who misses a midterm test due to illness should notify the instructor and the course coordinator as soon as possible, and **must submit a Student Declaration of Absence (SDA) Form through the course Brightspace page within three (3) calendar days following the last day of absence. There will be no make-up mid-term examinations. If the midterm is missed for medical reasons AND an SDA Form was submitted within the appropriate time period, the final grade will be based on the remaining evaluation items.**
- **PLEASE NOTE: it is not to the student's advantage to have their final mark depend on only the final exam and the labs/assignments**
- Absence from exams for non-medical reasons OR failure to submit the SDA Form (if absence is due to illness) is not acceptable. **A missed evaluation component for which no satisfactory arrangement has been made with the instructor and course coordinator (Dr. Andrew Roger) will be given a mark of zero**.
- **A student who misses both the midterm and the final exam will be given an F for the course.**
- **The Student Declaration of Absence form can only be submitted up to two (2) separate times per course during a term and only for absences of 3 days or shorter.** Students who exceed one or both limits must inform their course instructor and course coordinator (Andrew Roger) and will be required to register with an Advisor at Student Academic Success (SAS). If students have recurring short-term absences and do not register with SAS, it is at the instructors' discretion to disallow any further Student Declarations and deny alternate coursework arrangements. Please refer to the link below for further information on the University policy regarding Long-term absence: https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html

Learning Objectives

Students will be able to:

- understand the basic concepts of molecular evolution
- understand the theory of sequence alignment, sequence similarity assessment and database searching and conduct these analyses with online tools
- understand the theory of multiple sequence alignment and align sequences using online software tools
- understand the theory and applications of Hidden Markov Models in bioinformatics
- understand the theory underpinning estimating phylogenetic relationships amongst sequences
- conduct and interpret phylogenetic analyses using sophisticated computational methods
- understand how high throughput DNA sequencing data is analyzed in biomedical contexts
- understand the basic types and theory of supervised and unsupervised machine learning and their applications in bioinformatics
- understand basic concepts in microbiomics and conduct microbiomic analyses

Tentative schedule of lectures/labs for BIOC 4010/5010 – Bioinformatics (subject to change).

Date	Lecture Topic (tentative and subject to change)	Instructor
January 9	Intro. to bioinformatics and molecular evolution	Andrew Roger
January 11	Sequence comparisons and dot plots	Andrew Roger
January 16	Scoring matrices and alignment concepts	Kelsey Williamson
January 18	Pairwise alignment, BLAST (Problem set 1 assigned)	Kelsey Williamson
January 23	multiple alignment, profiles, motifs	Andrew Roger
January 25	**Lab 1 – Database searching and homology**	Williamson/Roger
January 30	Information theory and Hidden Markov Models (Problem set 2 assigned)	
February 1	Phylogenetics	Andrew Roger
February 6	**Lab 2 – Multiple sequence alignments, Profile searching etc.**	Williamson/ Roger
February 8	Phylogenetics	Andrew Roger
February 13	Phylogenetics (Problem set 3 assigned)	Andrew Roger
February 15	**Lab 3 – Phylogenetics**	Williamson/Roger
February 20- February 22	Study break	---------- ----------
February 27	Phylogenetics	Andrew Roger
February 29	**Midterm**	Andrew Roger
March 5	Next-generation sequence analysis and biomedical applications 1	Dan Gaston
March 7	**Lab 4 – Sars-Cov-2 typing and phylogenetics**	Williamson/Gaston
March 12	Next-generation sequence analysis and biomedical applications 2	Dan Gaston
March 14	**Lab 5 – Transcriptomics and differential expression analysis**	Sibbald/Gaston
March 19	Machine learning I	Andrew Roger
March 21	Machine learning II	Andrew Roger
March 26	Microbiomics using marker genes and metagenomics	Morgan Langille
March 28	**Lab 6 – Microbiomics – marker genes and metagenomics**	Williamson/Langille
April 2	Machine learning III and Graduate student presentations (Problem set assigned)	Andrew Roger
April 4	Graduate student presentations	Andrew Roger

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Student Resources and Support

University Policies and Programs

Important Dates in the Academic Year (including add/drop dates): http://www.dal.ca/academics/important_dates.html

Classroom Recording Protocol: https://www.dal.ca/dept/university_secretariat/policies/academic/classroom-recording-protocol.html

Dalhousie Grading Practices Policies: https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Grade Appeal Process: https://www.dal.ca/campus_life/academic-support/grades-and-student-records/appealing-a-grade.html

Sexualized Violence Policy: https://www.dal.ca/dept/university_secretariat/policies/health-and-safety/sexualized-violence-policy.html

Scent-Free Program: https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html

Learning and Support Resources

General Academic Support – Advising (Halifax): https://www.dal.ca/campus_life/academic-support/advising.html

General Academic Support – Advising (Truro): https://www.dal.ca/about-dal/agricultural-campus/ssc/academic-support/advising.html

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness.html

On Track (helps you transition into university, and supports you through your first year at Dalhousie and beyond): https://www.dal.ca/campus_life/academic-support/On-track.html

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Indigenous Connection: https://www.dal.ca/about-dal/indigenous-connection.html

Elders-in-Residence (The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit the office in the Indigenous Student Centre or contact the program at elders@dal.ca or 902-494-6803: https://cdn.dal.ca/content/dam/dalhousie/pdf/academics/UG/indigenous-studies/Elder-Protocol-July2018.pdf

Black Student Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre.html

South House Sexual and Gender Resource Centre: https://southhousehalifax.ca/about/

LGBTQ2SIA+ Collaborative: https://www.dal.ca/dept/vpei/edia/education/community-specific-spaces/LGBTQ2SIA-collaborative.html

Dalhousie Libraries: http://libraries.dal.ca/

Copyright Office: https://libraries.dal.ca/services/copyright-office.html

Dalhousie Student Advocacy Services: https://www.dsu.ca/dsas?rq=student%20advocacy

Dalhousie Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Human Rights and Equity Services: https://www.dal.ca/dept/hres.html

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Study Skills/Tutoring: http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Faculty of Science Advising Support: https://www.dal.ca/faculty/science/current-students/undergrad-students/degree-planning.html

Safety

Biosafety: http://www.dal.ca/dept/safety/programs-services/biosafety.html

Chemical Safety: https://www.dal.ca/dept/safety/programs-services/chemical-safety.html

Radiation Safety: http://www.dal.ca/dept/safety/programs-services/radiation-safety.html

Laser Safety: https://www.dal.ca/dept/safety/programs-services/radiation-safety/laser-safety.html